REMARKS

Rejections under 35 USC §103(a)

Claims 1-7 were rejected under 35 USC §103(a) as being obvious over Alexander (U.S. Patent No. 5,422,190), in view of Funahashi et al. (U.S. Patent No. 6,376,763).

(i) Claims 1 to 3 are directed to an electrically conductive paste for connecting thermoelectric materials comprising: specific powdery oxides described in (a) to (c) and at least one powdery electrically conductive metals elected from the group consisting of gold, silver, platinum, and alloys containing at least one of these metals. Claims 4 to 7 are directed to an electrically conductive paste for connecting a p-type thermoelectric material comprising: a powdery oxide described in (a) or (b) among the above-described components, and at least one powdery electrically conductive metal selected from the group consisting of gold, silver, platinum, and alloys containing at least one of these metals.

When these pastes are used for connecting thermoelectric materials, a suitable electrical conductivity is given to the connecting portion of the thermoelectric material, and separation at the connecting portion can be prevented even when repeating high-temperature power generation. Thus, good thermoelectric performance can be maintained over a long period of time.

(ii) Alexander (USP No. 5,422,190), cited in the Office Action, discloses in column 3, lines 25 to 42, a via fill paste comprising gold, silver, palladium and a refractory oxide.

As the Examiner indicates, Alexander discloses the paste including each component described above. Alexander, however, simply discloses as the refractory oxide, oxides

comprising metals such as zirconium, yttrium, ruthenium, etc., but it does not disclose the oxides (a) to (d) of Claim 1.

In this regard, the Examiner cites Funahashi et al. (USP No. 6,376,763), alleging that a complex oxide represented by the general formula $Ca_3RE_xCo_4O_y$ is shown in the abstract. In the previous formula, RE is defined as a rare earth element.

The applicant has amended Claims 1 and 4 to delete Y and lanthanoids from the definition of A^1 of the formula $Ca_aA^1{}_bCo_cA^2{}_dO_e$. Moreover, the oxide (d) of Claim 1 has been deleted. (The present invention is clearly distinguished from the oxide disclosed in Yoshimoto et al. (USP No. 5,352,299), which is explained later).

Further, in Claim 5, Y and lanthanoids have been deleted from the definition of A^1 of the formula $Ca_aA^1{}_bCo_4O_e$. These amendments make it clear that the complex oxide represented by the formulae $Ca_aA^1{}_bCo_cA^2{}_dO_e$ or $Ca_aA^1{}_bCo_4O_e$ according to currently amended Claims 1, 4 and 5 is a different material from that represented by the general formula $Ca_{3-x}RE_xCo_4O_y$ described in Funahashi et al.

Other powdery oxides recited in currently amended Claims 1, 4 and 5 are not disclosed in Alexander or Funahashi et al.

Therefore, even in view of a combination of the aforementioned References, it would not have been expected that an electrically conductive paste comprising a powdery electrically conductive metal together with a powdery oxide that is nowhere disclosed in Alexander and Funahashi et al., has excellent performance as a material for connecting thermoelectric materials.

(iii) Moreover, as is clear from the above arguments, the paste described in Alexander is directed to a via fill paste for use in the construction of electronic circuit devices, and thus discusses nothing about connecting thermoelectric material. Even though the paste requires conductivity, the aim of the invention of Alexander is to solve the problem of the electrical connection between a layer of conductive silver and a layer of conductive gold. This object differs from that of the present invention, which is connecting thermoelectric materials that are comprised of oxides. What Alexander discloses is a "via fill paste containing gold, silver, palladium, and a refractory oxide" as an appropriate via fill paste for the above objects.

On the other hand, Funahashi et al. discloses a complex oxide having excellent features as a p-type thermoelectric material, such as excellent heat resistance, chemical durability, and high thermoelectric conversion efficiency. Although these features are essential for thermoelectric materials, they are not important for via fill pastes. In particular, thermoelectric conversion efficiency is unnecessary for via fill pastes.

Accordingly, there is no reason for a person of ordinary skill in the art to use the oxide for the p-type thermoelectric material of Funahashi et al., as an oxide component of the paste described in Alexander.

(iv) The powdery oxide of the electrically conductive paste of Claims 1, 4 and 5 is nowhere disclosed in Alexander and Funahashi et al. Therefore, these claims patentably distinguish over Alexander and Funahashi et al.

Clams 2 and 3 depend on Claim 1, and Claims 6 and 7 depend on Claim 4. Accordingly, these claims also patentably distinguish over Alexander and Funahashi et al. for at least the same reasons.

Claims 8-11 were rejected under 35 USC §103(a) as being obvious over Alexander (U.S. Patent No. 5,422,190), in view of Yoshimoto et al. (U.S. Patent No. 5,352,299).

(i) Claims 8 to 11 are directed to an electrically conductive paste for connecting an n-type thermoelectric material comprising: a specific powdery oxide and at least one powdery electrically conductive metal selected from the group consisting of gold, silver, platinum, and alloys containing at least one of these metals. Considering Yoshimoto et al. (U.S.P. No. 5,352,299), Claims 8 to 11 have been rejected as being obvious over Alexander (U.S.F. No. 5,422,190) for the reasons similar to that for Claims 1 to 7.

Yoshimoto et al. is cited in place of Funahashi et al., which is cited as a reason for rejection of Claims 1 to 7, and discloses an oxide represented by the general formula $(Ln_{1-x}A_x)_2MO_4$ $(0.01 \leqq x \leqq 0.05)$. Among the oxides included in the paste of Claim 8, the oxide represented by the general formula $(Ln_sR^3_t)_2NiR^4_vO_w$ overlaps the one disclosed in Yoshimoto et al.

(ii) The applicant has amended Claim 8 to delete the oxide represented by the general formula $(Ln_sR^3_t)_2Ni_uR^4_vO_w$. The paste of currently amended Claim 8 now only includes as a powdery oxide the oxide represented by the formula $Ln_mR^1_nNi_pR^2_qO_r$.

Alexander and Yoshimoto et al. do not teach or suggest the complex oxide represented by the formula above. Therefore, it would not have been expected from the combination of the aforementioned References that the electrically conductive paste including the specific powdery oxide together with the powdery electrically conductive metal has excellent performance as a material for connecting thermoelectric materials.

Accordingly, Claim 8 patentably distinguishes over Alexander and Yoshimoto et al. Claims 9 to 11 depend on Claim 8. Claim 9 has been amended to delete the oxide represented by the formula $(La_sR^3_t)_2NiO_w$. Therefore, Claims 9 to 11 patentably distinguish over Alexander and Yoshimoto et al.

(iii) Additionally, Yoshimoto et al. simply discloses an oxide suitably used as an n-type thermoelectric material. Therefore, there is no reason for a person of ordinary skill in the art to use the oxide for the n-type thermoelectric material of Yoshimoto et al., as an oxide component of the via fill paste described in Alexander.

Claims 12-14 were rejected under 35 USC §103(a) as being obvious over Funahashi et al. (U.S. Patent No. 6,376,763), in view of Yoshimoto et al. (U.S. Patent No. 5,352,299) and Alexander (U.S. Patent No. 5,422,190).

Claims 12 to 14 are directed to a thermoelectric element wherein one end of a p-type thermoelectric material and one end of an n-type thermoelectric material are each connected to an electrically conductive substrate with an electrically conductive paste.

Claim 12 specifically recites a composition of the p-type thermoelectric material and n-type thermoelectric material, and further recites the use of the paste defined in Claim 1 for connecting these thermoelectric materials. Claim 13 recites the use of a paste having the same composition as Claim 4 for connecting a p-type thermoelectric material, and also the use of a paste having the same composition as Claim 8 for connecting an n-type thermoelectric material. Claim 14 recites the use of a paste having the same composition as Claim 5 for connecting a p-type thermoelectric material, and also the use of a paste having the sane composition as Claim 9 for connecting an n-type thermoelectric material.

As described above, Claims 12 to 14 relate to a thermoelectric element; however, the element of each claim features the use of a specific electrically conductive paste, i.e., the paste according to Claim 1, Claim 4, Claim 8 or Claim 9, for connecting thermoelectric material to an electrically conductive substrate.

As explained above, the electrically conductive paste for connecting thermoelectric materials described in these claims patentably distinguishes over a combination of Alexander and Funahashi et al., or a combination of Alexander and Yoshimoto et al.

Therefore, Claims 12 to 14 relating to a thermoelectric element in which a thermoelectric material is connected to an electrically conductive substrate using such pastes are unobvious over the aforementioned References.

Claims 15 and 16 were rejected under 35 USC §103(a) as being obvious over Funahashi et al. (U.S. Patent No. 6,376,763) and Yoshimoto et al. (U.S. Patent No.

5,352,299) and Alexander (U.S. Patent No. 5,422,190) as applied to claim 12 above, and further in view of Buist (U.S. Patent No. 4,859,250).

Claims 17 and 18 are rejected under 35 USC §103(a) as being obvious over Funahashi et al. (U.S. Patent No. 6,376,763 and Yoshimoto et al. (U.S. Patent No. 5,352,299) and Alexander (U.S. Patent No. 5,422,190) as applied to claim 13 above, and further in view of Buist (U.S. Patent No. 4,859,250).

Claim 15 is directed to a thermoelectric module comprising a plurality of the thermoelectric elements of Claim 12, and Claim 16 is directed to a thermoelectric conversion method using the thermoelectric module. Claim 17 is directed to a thermoelectric module comprising a plurality of the thermoelectric elements of Claim 13, and Claim 18 is directed to a thermoelectric conversion method using the thermoelectric module.

With regard to these claims, Buist (U.S.P. No. 4,859,250) is cited in addition to the above-mentioned References. Buist discloses in Fig. 3a a device in which the elements are connected in the same manner as in Claims 15 and 17. Fig. 4 shows a conversion method of positioning a module in a manner similar to that defined in Claims 16 and 18.

However, the module of Claim 15 comprises a plurality of the thermoelectric elements of Claim 12, and the module of Claim 17 comprises a plurality of the thermoelectric elements of Claim 13. As described above regarding Claims 12 to 14, these thermoelectric elements patentably distinguish over any combination of the aforementioned References. Therefore, Claims 15 and 17 directed to a thermoelectric module comprising the thermoelectric elements,

and Claims 16 and 18 directed to a thermoelectric conversion method using the module patentably distinguish over the aforementioned References.

In view of the aforementioned amendments and accompanying remarks, Applicants submit that the claims, as herein amended, are in condition for allowance. Applicants request such action at an early date.

If the Examiner believes that this application is not now in condition for allowance, the Examiner is requested to contact Applicants' undersigned attorney to arrange for an interview to expedite the disposition of this case.

If this paper is not timely filed, Applicants respectfully petition for an appropriate extension of time. The fees for such an extension or any other fees that may be due with respect to this paper may be charged to Deposit Account No. 50-2866.

Respectfully submitted,

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